ICEBO2007
Session 16

CC® Retrofits and Optimal Controls for Hot Water Systems

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Outline

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- Retrofits
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Introduction

❖Current issues

- Oversized boilers
- High operation and maintenance costs
- Low hot water supply and return temperature difference
- All pneumatic controls

❖Goals

- Properly size the boilers
- Optimize the heating system controls

System Information

Building

- Built in 1975
- 230,000 square feet
- Ten heating coils with 3-way valves at 10 AHUs
- Dual-duct terminal boxes

Hot Water System

- Three steam boilers (40,000 MBH)
- Three constant speed circulation pumps (1200 GPM/pump)
- Three constant speed secondary pumps (900 GPM/pump)
- Foot print: 5,000 ft^2
- 4,000 ft^2 heating surface in total

System Information

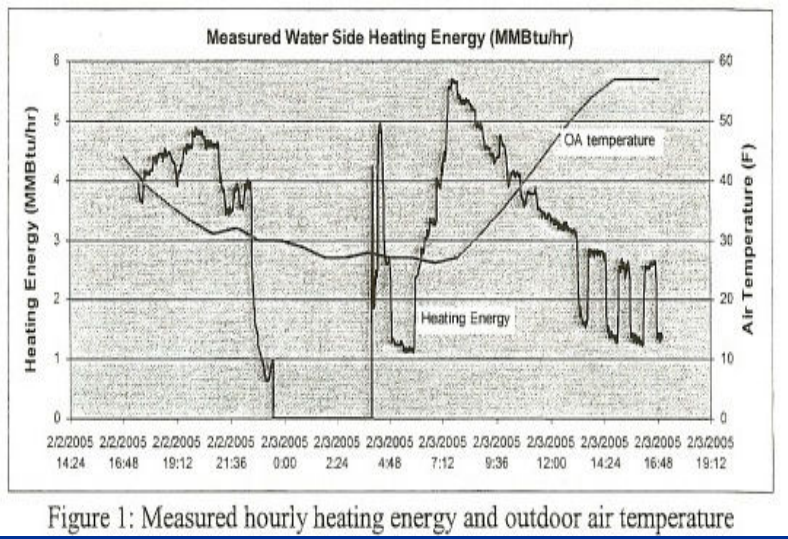


Figure 1: Measured hourly heating energy and outdoor air temperature

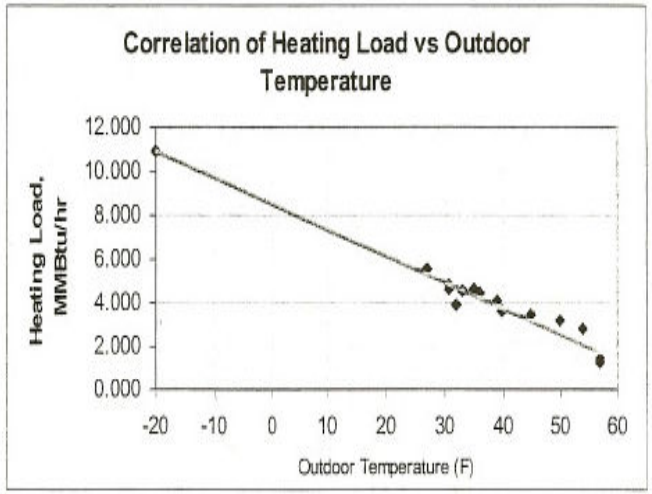


Figure 2: Correlation of the measured heating energy and outdoor air temperature

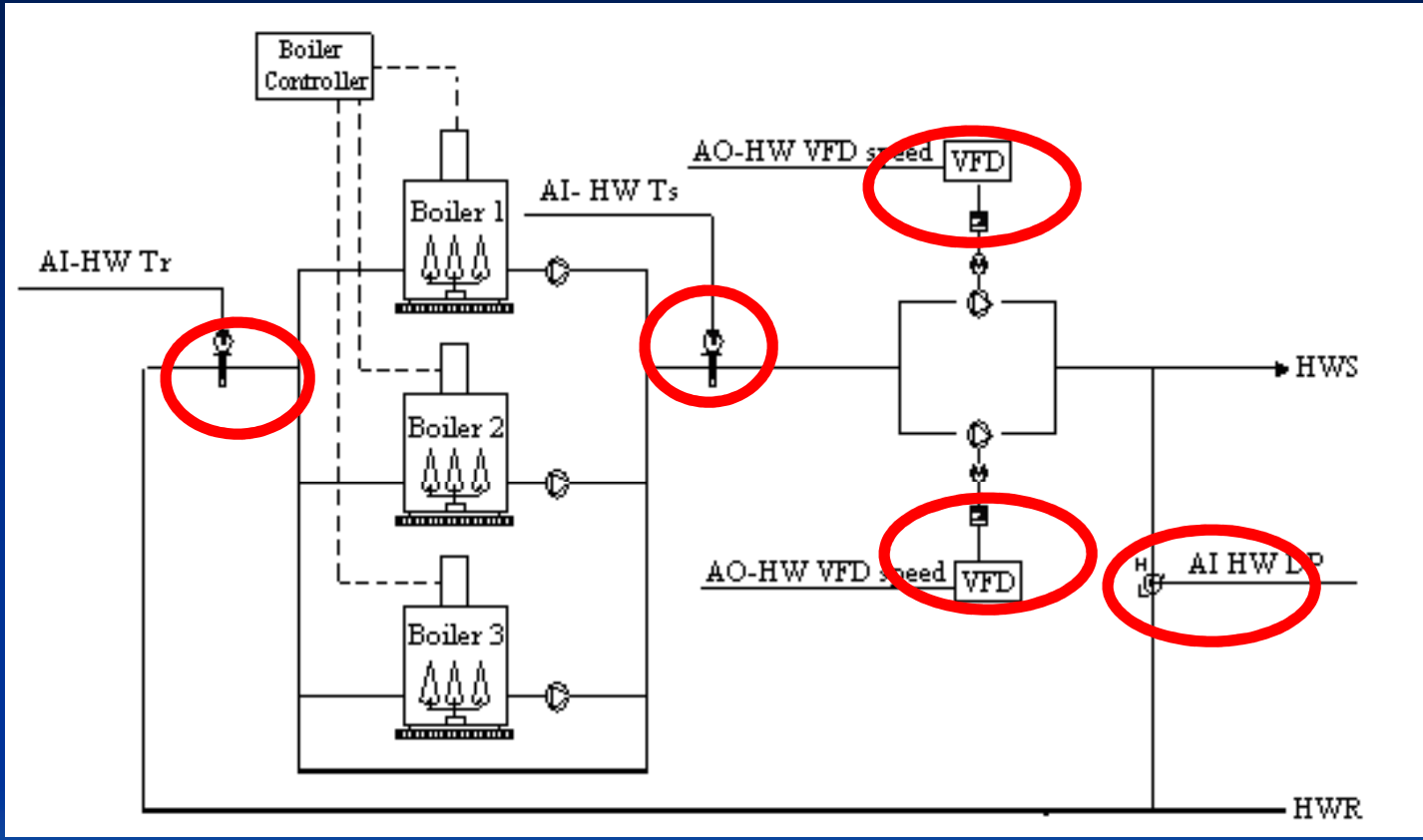
- The actual heating load was measured and identified as 11,000 MBH at Toa=-20 ºF.

Retrofits

Hot Water System

- Three hot water modular boilers (5,000 MBH in total)
- Three constant speed circulation pumps (170 GPM/pump)
- Two secondary pumps with VFDs (510 GPM/pump)
- Foot print: 800 ft^2
- 600 ft^2 heating surface

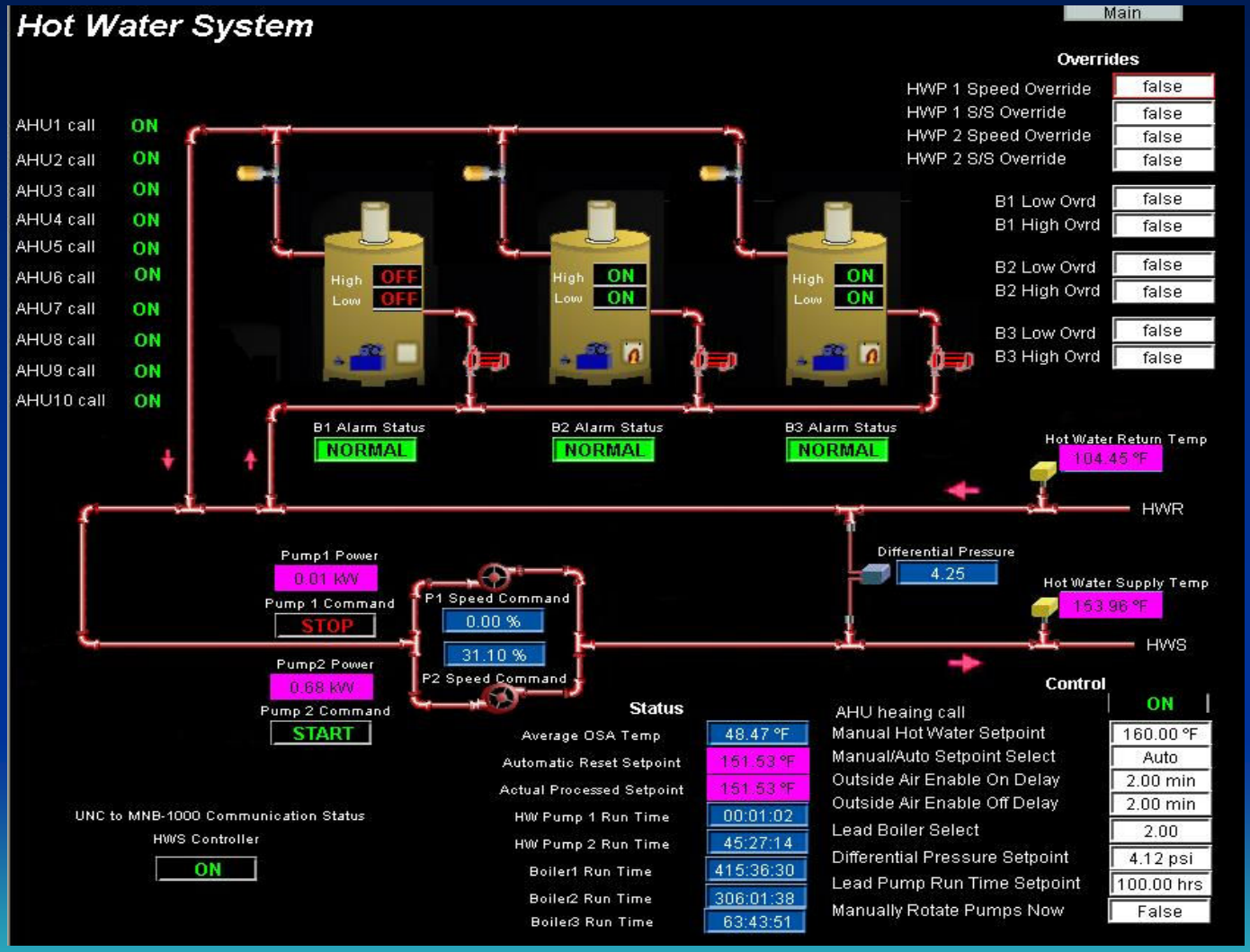
Retrofits



Schematic Diagram of Hot Water System

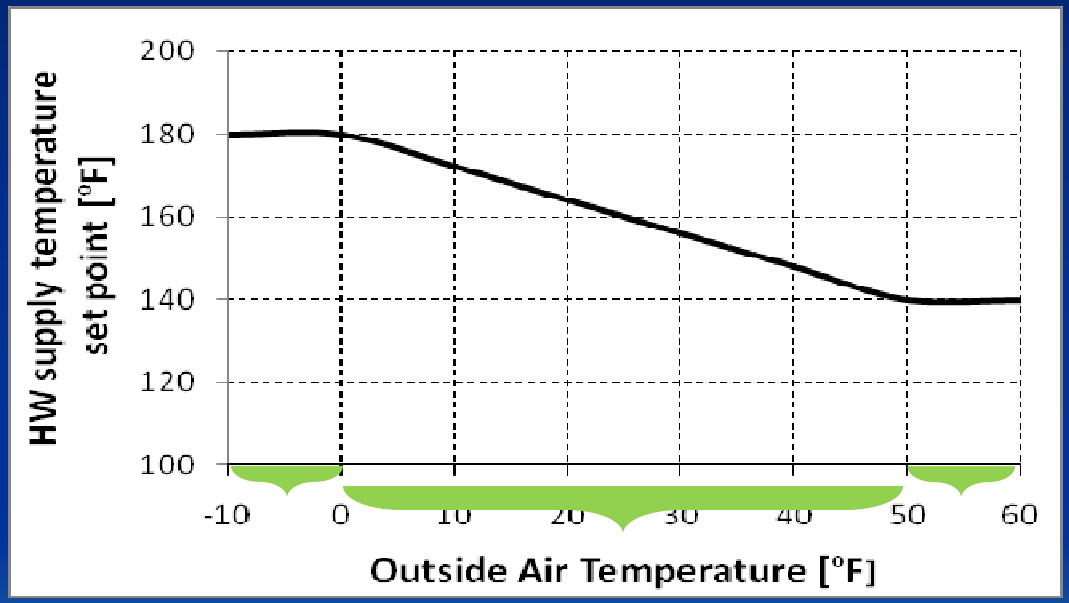
Optimal Control

Hot Water System On/Off



Hot Water Supply Temperature

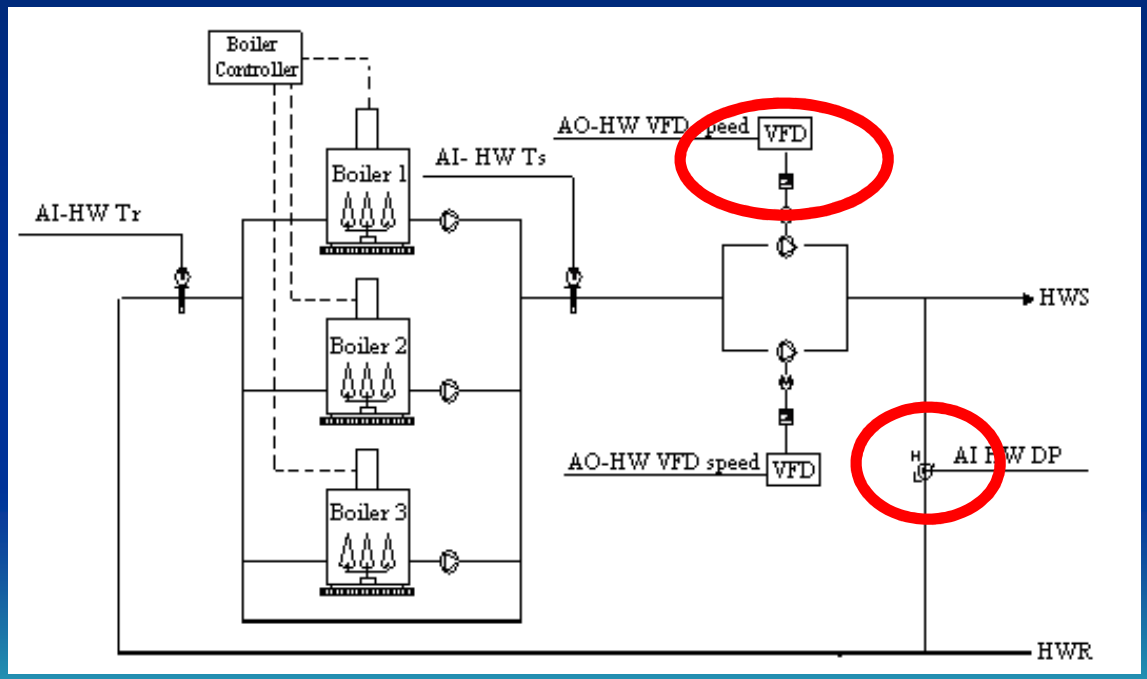
- Supply temperature set point reset
- Burners individually fired



$55 \leq T_{OA} \leq 65$

Hot Water Pump Speed

- Modulate to maintain the loop differential pressure at its set point
- DP set point reset based on the valve open position to ensure at least one valve 95% open



Results

$55 \le T_{OA} \le 65$

Hot Water Flow

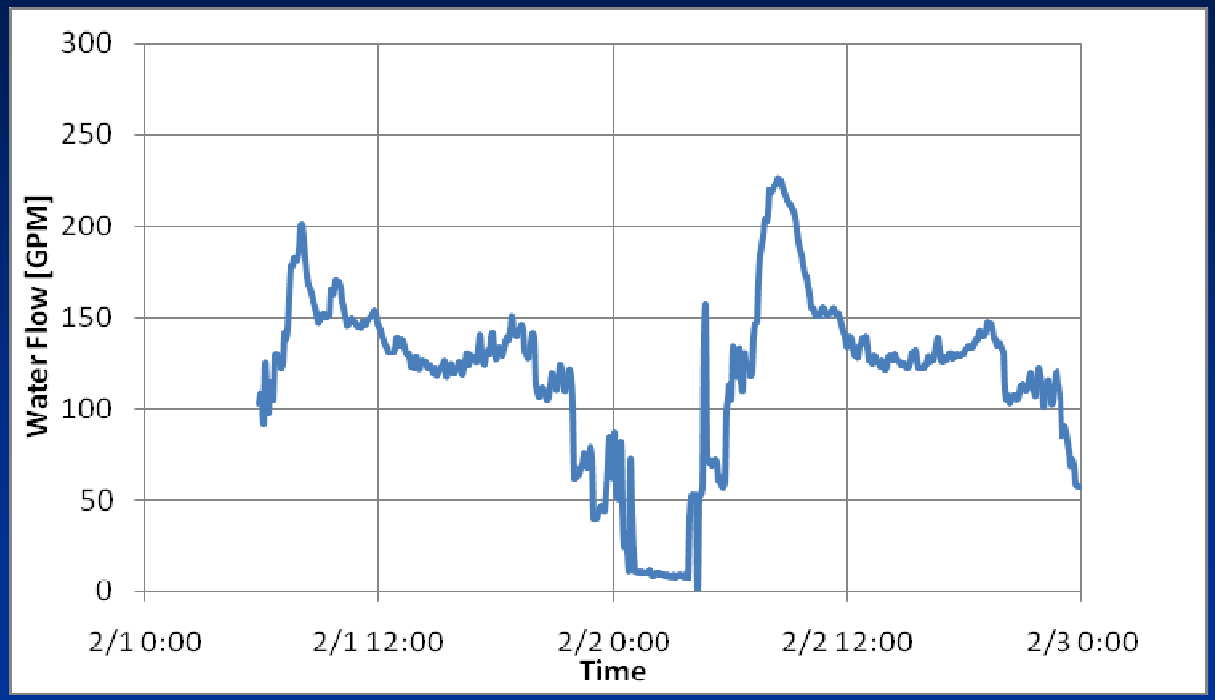
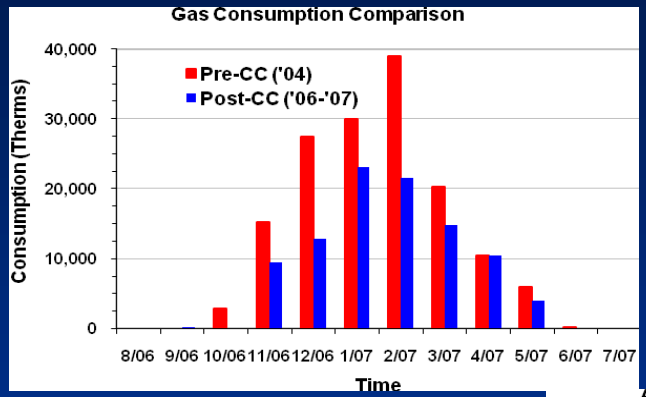
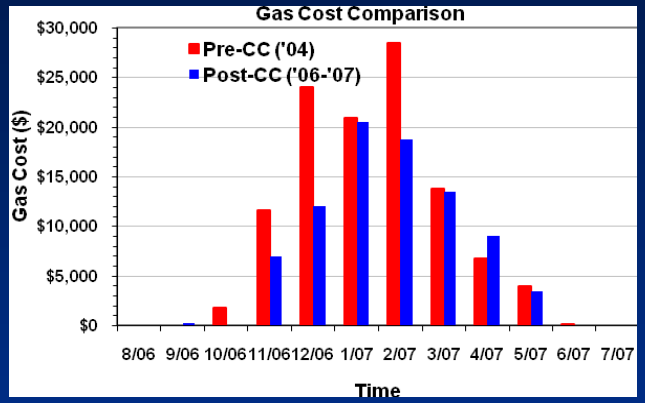


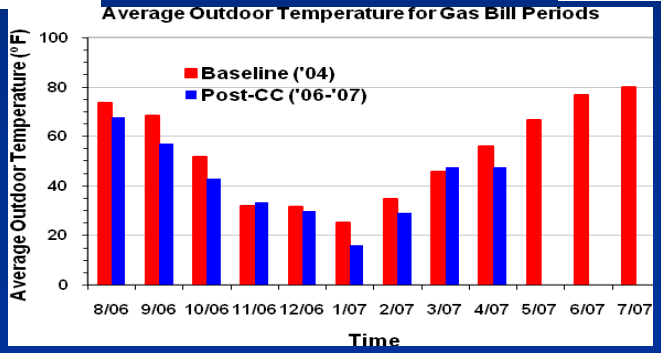
Fig. Hot Water Flow Trending Data from 02/01 to 02/03

- Reduce pump water flow under partial load
- The temperature difference between $T_{hw,s}$ and $T_{hw,r}$ is up to 30 ºF

Gas Savings







- Outside air: colder
- Gas price: increased (0.7 $/therm Jan, 2004 vs 0.89 $/therm, Jan, 2007)

- Annual gas consumption savings: 36%
- Annual gas cost savings: 43%

Conclusions

- Properly sized boilers reduce the foot print from 5,000 square feet to 800 square feet. It significantly increased the property value.
- Measured heating energy savings: 36%.
- The project payback is within 3 years.

Acknowledgement

The enthusiastic assistance and collaboration from Omaha Public Power District is greatly appreciated.

Special thanks extend to engineers, building owner of the case study building.

This project has full support from my group of Energy Systems Laboratory at University of Nebraska Lincoln.

Thanks for your kind attention!